Learning from 3D tomographic 21cm maps

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Abstract

Intensity Mapping targets the Universe from present time up to when it reionised and first galaxies formed, from small to large scales. Imaging of the 21cm signal, with redshift dependency added through frequency, can produce 3D light-cones that give valuable insight into structure growth, the inter-galactic medium as well as properties and environment of ionising sources. Due to the huge amount of data that radio interferometers, and especially the Square Kilometre Array (SKA) will produce, as well as the highly non-Gaussian nature of the measured signal, these data call for the development and application of methods beyond e.g. power spectrum statistics. In this talk I showcase the use of deep networks that are tailored for the 3D structure of tomographic 21cm light-cones of reionisation and cosmic dawn to directly infer e.g. dark matter and astrophysical properties jointly without an underlying Gaussian assumption. I compare different architectures and highlight how a comparably simple 3D convolutional network architecture becomes the best-performing model. For this 3D network I present well-interpretable gradient-based saliency as well as filter structures. I continue by discussing its robustness against foregrounds and systematics, first by inferring properties from mock observational light-cones with different levels of noise, and secondly by transfer learning between bare simulations and mocks. I finish by a glimpse at lower redshift results of the team *coin* for the recent SKA Science Data Challenge 2, where hydrogen sources where to be detected and characterised in a large (TB) data-cube of the hydrogen 21cm line. I will highlight lessons on the pitfalls of machine learning methods for such low signal-to-noise data.
Slides: in PDF
Video: https://youtu.be/QXS3zOdQxXY

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